## We claim:

A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

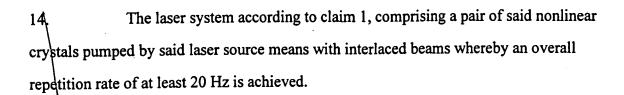
a laser source means for producing a pump beam having a wavelength ranging approximately from 1.0 to 1.1  $\mu m$ ,

a nonlinear crystal for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and

means for directing said idler beam onto said tissue to remove portions of said tissue primarily by a photo-mechanical ablation process.

- 2. The laser system according to claim 1, wherein said laser source means is a neodymium-doped laser.
- 3. The laser system according to claim 1, wherein said pump beam has a pulse duration of less than 50 ns, and a repetition rate of at least 10 Hz and a transverse mode structure consisting of single or multiple modes.
- 4. The laser system according to claim 1, wherein said nonlinear crystal is a Potassium Titanyl Phosphate (KTP) crystal.
- 5. The laser system according to claim 1, wherein the nonlinear crystal is rotatable about three principal axes.

- 6. The laser system according to claim 1, wherein said nonlinear crystal is made of a periodically poled non-linear material including KTP and isomorphs or LiNbO<sub>3</sub>.
- 7. The laser system according to claim 1, wherein said nonlinear crystal is tunable to optimize absorption in said tissue.
- 8. The laser system according to claim 1, wherein said idler beam has energy output of at least 1 mJ.
- 9. The laser system according to claim 1, wherein said idler beam achieves a thermal damage zone in corneal tissue of less than 2μm.
- 10. The laser system according to claim 1, wherein said surgical procedure is a corneal ablation procedure.
- 11. The laser system according to claim 10, wherein said corneal ablation procedure is a PRK technique based on a photospallation mechanism
- 12. The laser system according to claim 1, wherein said directing means includes three mirrors comprising an "L shaped" arrangement.
- 13. The laser system according to claim 1, wherein the nonlinear crystal is based on a doubly-resonant oscillator.



The laser system according to claim 1, wherein the fluence onto the eye is between 100 mJ/cm<sup>2</sup> and 500 mJ/cm<sup>2</sup>.

16. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser source means for producing a pump beam having a wavelength ranging approximately from 1.0 to 1.1μm,

a nonlinear crystal for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range approximately between 2.85 and 3.0 µm; and

means for directing said idler beam onto said tissue to remove portions of said tissue primarily by a photo-mechanical ablation process.

7. A method for performing a laser surgical procedure on a tissue, said method comprising the steps of:

generating a pump beam having a wavelength ranging approximately from 1.0 to 1.1  $\mu m_{\mbox{\scriptsize m}}$ 

passing said pump beam through a nonlinear crystal to
parametrically convert the pump beam into an idler beam and a signal beam,

said idler beam having a wavelength in the mid-infrared range corresponding approximately to an absorption peak of said tissue; and directing said idler beam onto said tissue to remove portions of said tissue primarily by a photo-mechanical ablation process.

- 18. The method according to claim 17, wherein said laser source means is a neodymium-doped laser.
- 19. The method according to claim 17, wherein said pump beam has a pulse duration of less than 50 ns, a repetition rate of at least 10 Hz and a transverse mode structure consisting of single or multiple modes.
- 20. The method according to claim 17, wherein said nonlinear crystal is a Potassium Titanyl Phosphate (KTP) crystal.

The method according to claim 17, wherein the nonlinear crystal is rotatable about three principal axes.

- The method according to claim 17, wherein said nonlinear crystal is made of a periodically poled non-linear material including KTP and isomorphs or LiNbO<sub>3</sub>.
- 23. The method according to claim 17, further comprising the step of tuning said nonlinear crystal to optimize absorption in said tissue.
- The method according to claim 17, wherein said idler beam has energy output offat least 1 mJ.

The method according to claim 17, wherein said idler beam achieves a thermal damage zone in corneal tissue of less than 2μm.

The method according to claim 17, wherein said surgical procedure is a corneal ablation procedure.

- 27. The method according to claim 26, wherein said corneal ablation procedure is a PRK technique based on a photospallation mechanism
- 28. The method according to claim 17, wherein said directing means includes three mirrors comprising an "L shaped" arrangement.
- The method according to claim 17, wherein the nonlinear crystal is based on a doubly-resonant oscillator.
- 30. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser source for producing a pump beam having a wavelength ranging from approximately 0.85 to 0.9  $\mu m$ ;

a nonlinear crystal rotatable about three principal axes for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range approximately between 2.85 and 3.0µm, wherein said nonlinear crystal is noncritically phase matched and said crystal is oriented such that phase matching is achieved along a propagation direction of said idler beam parallel to one of said principal axes; and

means for directing said idler beam onto said tissue.

31. A mid-infrared laser system for performing a laser surgical procedure on a tissue, said system comprising:

a laser source for producing a pump beam having a wavelength ranging from approximately 0.85 to 1.1μm, said pump beam having a defined polarization;

a nonlinear crystal for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range between approximately 2.85 and 3.0µm;

fiber means for coupling said laser source to said nonlinear crystal, said fiber means maintaining said polarization; and

means for directing said idler beam onto said tissue to remove portions of said tissue primarily by a photo-mechanical ablation process.

32. A method for removing corneal tissue from an eye of a patient, said method comprising the steps of:

generating a pump beam having a wavelength of approximately 1 µm; passing said pump beam through a nonlinear crystal to parametrically convert the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range corresponding to a corneal absorption peak; and

scanning said beam across an area of said corneal tissue in a predefined pattern to remove portions of said corneal tissue primarily by a photo-mechanical ablation process.

The method according to claim 32, wherein said laser source means is a neodymium-doped laser.

- 34. The method according to claim 32, wherein said pump beam has a pulse duration of less than 50 ns, and a repetition rate of at least 10 Hz and a transverse mode structure consisting of single or multiple modes.
- 35. The method according to claim 32, wherein said nonlinear crystal is a Potassium Titanyl Phosphate (KTP) crystal.
- The method according to claim 32, wherein the nonlinear crystal is rotatable about three principal axes.
- The method according to claim 32, wherein said nonlinear crystal is made of a periodically poled non-linear material including KTP and isomorphs or LiNbO<sub>3</sub>.
- 38. The method according to claim 32, further comprising the step of tuning said nonlinear crystal to optimize absorption in said tissue.
- The method according to claim 32, wherein said idler beam has energy output of at least 1 mJ.
  - The method according to claim 32, wherein said idler beam achieves a thermal damage zone in corneal tissue of less than 2μm.

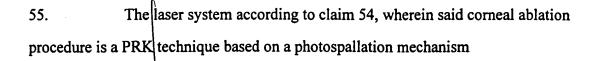
The method according to claim 32, wherein said surgical procedure is a corneal ablation procedure.

- The method according to claim 41, wherein said corneal ablation procedure is a PRK technique based on a photospallation mechanism
- The method according to claim 32, wherein said directing means includes three mirrors comprising an "L shaped" arrangement.
- The method according to claim 32, wherein the nonlinear crystal is based on a doubly-resonant oscillator.
- A mid-infrared laser system for removing corneal tissue from an eye of a patient, said system comprising;
- a laser source means for producing a pulsed pump beam having a wavelength ranging approximately from 1.0 to 1.1  $\mu$ m;
- a nonlinear crystal for parametrically converting the pump beam into an idler beam and a signal beam, said idler beam having a wavelength in the mid-infrared range corresponding approximately to a corneal absorption peak; and

means for directing said idler beam onto said eye in a predefined pattern to remove portions of said corneal tissue primarily by a photo-mechanical ablation process.

The laser system according to claim 45, wherein said laser source means is a neodymium-doped laser.

- 47. The laser system according to claim 45, wherein said pump beam has a pulse duration of up to 50 ns, and a repetition rate of at least 10 Hz and a transverse mode structure consisting of single or multiple modes.
- 48. The laser system according to claim 45, wherein said nonlinear crystal is a Potassium Titanyl Phosphate (KTP) crystal.
- The laser system according to claim 45, wherein the nonlinear crystal is rotatable about three principal axes.
- The laser system according to claim 45, wherein said nonlinear crystal is made of a periodically poled non-linear material including KTP and isomorphs or LiNbO<sub>3</sub>.
- 51. The laser system according to claim 45, wherein said nonlinear crystal is tunable to optimize absorption in said tissue.
- 52. The laser system according to claim 45, wherein said idler beam has energy output of at least 1 mJ.
- The laser system according to claim 45, wherein said idler beam achieves a thermal damage zone in corneal tissue of less than 2μm.
- 54. The laser system according to claim 45, wherein said surgical procedure is a corneal ablation procedure.



- 56. The laser system according to claim 45, wherein said directing means includes three mirrors comprising an "L shaped" arrangement.
- 57. The laser system according to claim 45, wherein the nonlinear crystal is based on a doubly-resonant oscillator.
- The laser system according to claim 45, comprising a pair of said nonlinear crystals pumped by said laser source means with interlaced beams whereby an overall repetition rate of at least 20 Hz is achieved.
- 59. The laser system according to claim 45, wherein the fluence onto the eye is between 100 mJ/cm<sup>2</sup> and 500 mJ/cm<sup>2</sup>.

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